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Human Waste Sanitation Studies

Contract No. DA-44-009-AMC-537(T)
Project Order No. OCD-OS-63-235

Submitted by

TRUESDAIL LABORATORIES, INC.
Los Angeles, California

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PREFACE

This contract, DA-44-009-AMC-537(T), was issued by the United States Army Engineer Research and Development Laboratories, Fort Belvoir, Virginia, under Project Order Authorization OCD-OS-63-235. Initiation date was 4 April, 1964, closing date 1 June, 1965. Prime contractor was Truesdail Laboratories, Inc., Los Angeles, California.

The investigations were conducted principally by the Project Manager, Mr. Clyde L. Blohm, with assistance as needed from the staffs of the prime and sub-contractors. The sanitary tests and bacteriological work were executed by Truesdail Laboratories and sub-contractor Applied Biological Laboratories, Inc., of Glendale, California. The engineering design and fabrication of the sanitary vaults were done by sub-contractor Monogram Industries, Inc., Sanitary Systems Division, Culver City, California.

Particular thanks must go to several members of the local sales staff and the central professional laboratory staff of the Dow Chemical Company of Midland, Michigan. They gave generously of their time and materials, both in providing special sanitizing agents for testing, and in providing the packaging materials. Additional thanks must go to the Los Angeles Custom Packaging Company, who furnished gratis the speciment packages of the chemical sanitizing agents.

Finally, thanks go to Professor J. S. McAnally of Occidental College for his consulting assistance in the technical direction of the work and in review and assistance in preparation of the reports.

The USAERDL Project Engineer, Mr. Paul E. DesRosiers, Jr., is to be commended for his cooperation in the general direction and administration of the contract.

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ABSTRACT

Investigations have been pursued into the handling and storage of human wastes as they might be encountered under occupancy conditions in Office of Civil Defense fallout shelters. A chemical sanitizing and odor control agent has been selected from a number tested. This preferred agent is a simple physical mixture of two parts sodium bisulfate and one part copper sulfate pentahydrate, used in the waste container at the contentration of one pound per ten gallons (12,000 ppm) of accumulated wastes. One pint of oleic acid (commercial red oil) may or may not be used as a vapor barrier to improve odor control. General criteria have been established for the specification of such control agents which may be other than the one selected.

Design studies were conducted for the fabrication of a Sanitary Vault intended for use in fallout shelters. The vault is equipped with two seats and has a useable fill volume of 70 gallons of mixed wastes. Four prototype units were constructed for testing.

Recommendations for further work have been made.

INTRODUCTION

The work conducted under this contract and reported here is an extension of prior work done under USAERDL Project 8A72-04-001-29, and reported in Branch Report entitled "Investigation of Low-Cost Sanitation Systems", 19 November, 1962.

Preliminary studies performed under the earlier contract cited had shown that simple and inexpensive chemical mixtures could be used for sanitary and odor control of human wastes in so-called "dual-purpose water storage and commode drums, 17.5 gallon". However, many of the variables involved needed further evaluation in order to arrive at a practical system. In addition, the earlier work had encompassed preliminary studies on a "sanitary vault", which might be more suitable for the required task than the steel drums. This design, too, needed further study and evaluation in the direction of size, materials, fabrication methods and associated factors.

A program was established under this contract to perform some additional laboratory screening tests of the better agents selected from those previously studied, to be followed by a considerable number of actual use tests with the commode drums in order to evaluate required concentrations of agents and other factors, such as conditions of use, including temperature and relative humidity.

The program also included more extensive design studies on the Sanitary Vault concept, and the fabrication of four prototype units for testing in a fallout shelter (or elsewhere).

DISCUSSION

Sanitizing and Odor Control Agent.

Laboratory Screening Tests. Inasmuch as the previous work, as reported (vide supra), contained a rather detailed discussion of the problems involved in the handling of human wastes under the conditions specified, together with suggestions for methods of attack, this discussion will be limited to covering the work executed under this contract.

As may be seen from Table I, Appendix II, ten different groups of chemical agents, together with a control, were evaluated in the preliminary laboratory screening tests. This first series of tests was followed by a second series, using those chemicals appearing the most promising from the first series, but generally at different concentrations. Table II presents the test results.

Certain anomalies appear in the test results, the reasons for which are somewhat obscure. In the first series, no gas formation was observed in the controls, nor was there any evidence of coliforms after eight days' incubation. However, the initial pH of the mixed excreta was much higher than should be expected, which may have been due to urea hydrolysis during the urine collection period. This, together with the vigorous growth of both aerobes and anaerobes, as shown by the plate counts, may have completely inhibited any coliform growth, or at least evidence thereof by APHA tests. In the second series, the urine was collected over a much shorter time period, and it will be seen that the initial pH of the excreta mixture was about normal, viz., 7.3. While there was gas formation by the control of this series, again there was no coliform evidence after eight days' incubation, although the 20-hour test was positive.

It is apparent that, if this type of test is to be used as more than a very rough screening test, further refinement will be necessary with regard to media and test conditions.

The most promising materials of those tested, as judged by the overall results, were:

Copper sulfate pentahydrate-Sodium bisulfate,
Boric acid-Sodium perborate,
Saponified cresylic acids,
MIL-D-51061.

Privy Tests. Based on the results described above, a program was delineated for the actual use testing of the more promising materials, using the 17.5 gallon polyethylene-lined steel commode drums, set up in a small enclosed privy. Two series of tests were run in duplicate at two different locations and with two different groups of people.

Table III, Appendix II, lists the whole series of proposed tests. This list was started initially with tests Nos. 1 through 18, then was developed further as the testing proceeded. Tables IV, V, VI, and VII, Appendix II, present, respectively:

Privy Use Record,
Bacteriological Examinations,
Privy Use Temperature and Relative Humidity Conditions,
Drum Storage Temperature and Relative Humidity Conditions.

In general, the results of the Privy Tests confirmed those obtained in the screening tests, with the exception of the boric acid-sodium perborate mixture. In the screening tests, this mixture turned out rather well, but the incubated mixture was thoroughly mixed. Because of the difficult wettability of boric acid, it was found that when the mixture was added to a commode drum, there was essentially no mixing, and apparently little solution in order for diffusion to take place. As a result, this mixture was quite unacceptable in the privy tests, and further testing of it was discontinued. By the same token, it was felt that there was little use in testing the admixture of sodium perborate with other compounds.

Although several new materials were tested in the privies, as listed in Table III, only the three initially found promising finally turned out to be those selected. Of these, the copper sulfate pentahydrate-sodium bisulfate mixture showed the best over-all performance (cf. tests Nos. 1-4, 31, 32, 35, 36, 43, 44). While the saponified cresylic acids did a good sanitizing job, their rather strong inherent odor was objectionable to some individuals, although others did not find it too bad. The MIL-D-51061 suffered from the problem of a great amount of ammonia evolution, due to the high pH of the mixture, resulting in a very objectionable odor situation, although sanitary control was satisfactory in general (cf. tests Nos. 15-18, 41, 42).

The other materials tested failed on either sanitary control, odor control, or both, as shown by results listed in the Tables.

Several adjuncts were tried in an effort to potentiate the efficacy of the better control chemicals. The use of a vapor barrier appears to improve results slightly, although the subjective observations are difficult to evaluate. It was felt that the substitution of oleic acid for mineral oil gave some improvement, as it tended to film better. The addition of wetting agents to aid penetration gave no discernible improvement (cf. tests Nos. 37, 38, 47, 48). The one test pair run with dimethyl sulfoxide (DMSO) performed well sanitation-wise, but the inherent odor of the penetrant was objectionable, (cf. tests Nos. 35, 36.)

Thorough consideration of all the test results leads to the selection of the copper sulfate pentahydrate-sodium bisulfate system as the best agent for the task, at least in the commode drums, all criteria being considered. Sanitary control is good, odor control fair, packaging and handling appear to present no problems, human toxicity is low, cost is minimal, and the chemicals are common articles of commerce, available on short notice nearly everywhere. Its one disadvantage is its rather high corrosivity to metals, particularly aluminum. For this reason, the sanitary vaults and associated equipment, such as the pump, must be well protective coated if made of metal, or, preferably, they should be made of a corrosion resistant plastic, such as polyethylene or ABS. Corrosion was no problem with the double polyethylene-lined steel commode drums, even where there were liner failures, over a storage period of up to 30 days.

The corrosion problem is not readily solved in the copper sulfate system. It is apparent from examination of the test data that low pH, preferably less than 4.0, is a definite requirement for obtaining good sanitary control. In tests with copper sulfate-sodium bisulfate where the concentration of the latter was sufficiently small to let the pH rise above 4.0, coliforms appeared. On the other hand, low pH alone is not sufficient for control, as shown by the laboratory screening tests. One pair of tests, 45 and 46, were run using sodium dihydrogen phosphate as acidulant. However, an insufficient amount was used, and the pH in the system rose to nearly 6.0, with resultant coliform growth. Time did not permit repetition of this system with a higher concentration of the acidulant. Furthermore, the phosphate ion may contribute to bacteriological growth because of its importance as a nutrient. However, use of such an acidulant might mitigate the corrosion to some degree, since phosphatic salts are known to be less corrosive to metals than sulfates. Another possible substitution might be sulfamic acid, again a less corrosive material, but still a strong acid.

Some comments are in order on the problem of odor control. As stated above, the privy tests were run at two different locations, with two different groups of people. The users in each case were laboratory scientists and technicians. At Truesdail Labs., these people were all chemists, used to working in a relatively "clean" environment. At Applied Biological Sciences Labs., many of the people were bacteriologists and biological chemists, and were quite accustomed to working with large numbers of animals, which were kept on the laboratory premises. In general, the latter group found the commode system less objectionable with regard to odor, although the average temperature during the period of the tests was several degrees higher than at Truesdail. In addition, the contents of the drums were stirred after each chemical addition at Truesdail, not stirred at ABSL. This difference in procedure may also have had some bearing on the odor problem.

Further, with regard to odor, there is a substantial difference in the reactions of individuals to any specific odor situation. In nearly all cases, where odor was not completely foul, there was a difference of opinion as to its acceptability. Finally, there were definite psychological problems. It is extremely difficult to get people enthused over this kind of investigation, so that, in general, all engaged were inclined to be rather critical of all the tests. Furthermore, there was a marked deterioration in attitude as the test period extended, since it lasted a total of about six months. In contrast, under the rigorous conditions of enforced fallout shelter occupancy, where there will be many psychological problems, the odor situation in the sanitary area may be found to be reasonably acceptable to the occupants. It is known, for example, that individuals suffer olfactory fatigue rather quickly in a closed environment, and this fact alone may mitigate the problem.

Finally, all the above applies to experience with the 17.5 gallon commode drums. What differences may appear in the use of sanitary vaults are not really possible to predict, pending their actual testing under use conditions. A somewhat similar vault unit, using the copper sulfate-sodium bisulfate mixture, was tested by the Navy at Port Hueneme. While this unit had an electrically driven recycle flush system, the results obtained were quite satisfactory over periods of up to two weeks without emptying. As a result, the unit has been shipped to McMurdo for testing under Arctic conditions. It may be, therefore, that the vaults will perform better than the static drums.

One of the major difficulties encountered with the use of any of the agents in the commode drums was that of getting a thorough admixture of the agent with the commode contents. The lack of mixing undoubtedly contributed to lack of performance in many cases. It has been theorized that the efficacy of the copper sulfate-sodium bisulfate system is enhanced because the salts are quite soluble, completely ionized in solution, and the ions are rather small, permitting ready diffusion. Some of the synthetic organic agents, which perform well in laboratory tests, do not possess these properties, and thus do not work so well in actual field use.

On the other hand, the sanitary vaults may provide a better situation for agent action, since it is expected that the liquid-to-solid ratio will be somewhat greater, and, if the contents are recirculated occasionally by use of the pump, overall performance may be substantially improved.

Packaging. Packaging studies were conducted on the dry chemical mixture of copper sulfate pentahydrate and sodium bisulfate. This work was pursued with the generous and gratis cooperation of the Dow Chemical Company, who supplied materials, and the Los Angeles Custom Packaging Company, who did the actual packaging.

Specimen packages were made up for testing, in accordance with the work description, in one-half pound pouches, and in one pound preformed gusset bags. Six different materials were used for the half-pound flat pouches (Laminate materials are from outside to inside of pouch):

1. Dow Triple laminate, 25-lb. paper/ 0.00035 foil/ 0.001 polyethylene film.
2. Dow Quadruple laminate, 25-lb. paper/ 0.0005 polyethylene film/ 0.00035 foil/ 0.002 polyethylene film.
3. Dow Quadruple laminate, 195 cellophane (ca. 0.001)/ 0.0005 polyethylene film/ 0.0005 foil/ 0.0015 polyethylene film.

4. Dow quadruple laminate, 30-lb. glassine/ 10 lb. (ca. 0.0007) polyethylene film/ 0.00035 foil/ 0.0015 medium density polyethylene film.
5. Dow Triple Laminate, 0.001 cellulose acetate/ 0.001 foil/ 0.0005 vinyl heat seal coating.
6. Dow Triple Laminate, 0.001 cellulose acetate/ 0.001 foil/ 0.0002 vinyl heat seal coating.

The gusset bags were furnished by Continental Can Company as a commercial coffee bag. Since these packages were quite unsatisfactory, no attempt was made to get the laminate specifications.

Two one-pound specimen flat pouches were made of an unknown laminate stock, just to see if it were possible to package one pound of the dry chemicals in this type of pouch. It was found that such a package could readily be made on standard equipment.

Four each of the one-half pound pouches, and four of the gusset bag one pound packs were placed in a testing cabinet and were held at 70°C. and 100% relative humidity for approximately 135 hours. As can be seen from Table VIII, Appendix II, failures occurred for all materials except items 3 and 4. The packages made of item 3 material stood up fairly well under the test conditions, although some delamination developed on the outside of the packet. This material would probably be satisfactory for the package requirements. The packages made of item 4 material stood up excellently under the test conditions. There was no evidence of failure either inside or outside. The caking, as pointed out in the discussion below, results from inherent characteristics of the chemicals. This material, a quadruple laminate of:

30 lb. glassine/ 10 lb. polyethylene/ 0.00035 foil/ 0.0015 medium density polyethylene

is the material of choice, and is believed to be quite adequate for the required service.

The test data make it evident that the medium density polyethylene film is much superior, and is really necessary to prevent delamination and possible corrosive attack of the foil.

The physical mixture of the copper sulfate pentahydrate and sodium bisulfate presents an inherent characteristic problem. Apparently the sodium bisulfate, a deliquescent solid, reacts with the hydration water in the copper sulfate, so that the mixture, as prepared by blending in an open container, rapidly becomes quite moist. However, since the mixture as packaged need not be uniform, pouches can be filled by a double fill process, and thus the materials will remain dry and flowable for handling in the filling operation.

The foregoing characteristic does lead to some caking in the pouch under the accelerated test conditions. It is felt, however, that this partial caking, in the successful packaging material, will not present any difficulty in ultimate use.

The caking observed is relatively soft, and can easily be broken up by gentle kneading with the fingers before the pouch is opened. The contents of the pouch are somewhat sticky when opened, but can readily be shaken from the pouch. Inasmuch as the chemicals are very soluble in water, no difficulty is foreseen in utilization.

No accelerated storage tests were run on the oleic acid, as it was felt that this is a common article of commerce, readily available in one gallon metal cans or polyethylene bottles.

Specific cost data on the preferred packaging materials are presented in Appendix IV. Suffice it to say that the relative cost of packaging materials will not affect the cost of the final package significantly.

A discussion of cost for chemical agents and packaging is included in the referenced Appendix.

Sanitary Vault.
Further design studies were undertaken, based on preliminary work done and reported under USAERDL Project 8A72-04-001-29 (Loc cit).

The final design is shown in Monogram Industries Drawing No. 2760, a reduced copy of which is included in Appendix No. V. Dwgs. Nos. 2761 to 2774, inclusive, are forwarded separately and are not a part of this report. Reproducible Master drawings are on file for reference.

The unit as shown is furnished as a two seater, with a total useable volume of about 70 gallons of mixed wastes. Predicated, under fall-out shelter occupancy conditions, on a per person discharge, including all wastes, of one-half gallon per day, the vault will accommodate 70 persons for two days before emptying. The discharge pump unit is so arranged that it may be used for recirculation of the vault contents for better mixing.

Some problems are foreseen with this particular design, one in particular being the accumulation of relatively dry solids in the center of the tank, because of the flat bottom. On the whole, it is felt that the vault will be satisfactory, but further design study would undoubtedly lead to improvement.

Materials of construction were investigated, and at the present time it appears that carbon steel with a corrosion resistant coating is the best selection. Currently, the unit is a bit too large for blow-molding or other plastic construction. However, as these methods are further developed, they may lead to a less expensive unit.

CONCLUSIONS

From the results of the total work done to date, it is concluded that reasonably satisfactory sanitary and odor control can be provided for accumulation and handling of mixed human wastes under fallout shelter occupancy conditions.

The preferred chemical control agent is a two-to-one mixture of sodium bisulfate and copper sulfate pentahydrate, used at the concentration level of one pound per each ten gallons of mixed wastes. This agent is suitable in both dual-purpose water container-commode 17.5 gallon drums, or in a bulk storage container such as the sanitary vault. A vapor barrier, such as oleic acid or mineral oil, may be used as an adjunct, although the subjective observations made during the privy tests were not conclusive as to whether or not odor control was appreciably improved by this device.

Other control agents may be used, such as saponified cresylic acids or MIL-D-51061, but the current series of tests indicate that they are less effective, and more expensive, than the preferred selection.

A sanitary vault equipped with a manual pumping system has been designed and fabricated, and is technically feasible for the required service. The entire unit, including the pump, weighs about 200 lbs., and preliminary estimates for limited production quantities indicate a cost of not more than $350.00 per unit.

While the chemical treatment studies have led to a workable solution to the waste handling problem in the commode drums, the utilization of this treatment in the sanitary vault-pumping system requires further study. Such additional studies should include full scale tests followed by more intensive laboratory and engineering analysis of chemicals and equipment needed to make the concept more suitable for the intended civil defense use.

RECOMMENDATIONS FOR FUTURE WORK

In the interests of improving efficacy and reducing the costs of the fallout shelter waste handling system, and in view of new thinking in some of the overall concepts, additional work is recommended.

While the sanitary work performed under this contract was all done with the static, dual purpose water storage-commode drum system, some of the more recent planning in the fallout shelter program indicates the possibility of abandonment of this concept. Such planning has been oriented toward the use of the sanitary vaults and/or the use, at least in some shelters, of existing flush toilet sanitary facilities.

While the sanitary vault design has been studied, and preliminary design parameters have been fixed, the unit has not been tested under even simulated use conditions. Therefore, although it is believed that the results from the static drum experiments are amenable to application to the vault in a general way, there is no evidence to expect a direct translation. For this reason, testing of the vault is mandatory.

It is true that plans have been made to make at least one test of the vault concept in a fallout shelter occupancy test, but such testing will necessarily be limited to one or two sets of data, hardly enough to provide adequate information for determining the limits of the important parameters. It is entirely likely that the chemicals found effective in the static tests will be much more effective in the vault, due to larger liquid volume and the capability of mixing by use of the pump. Thus, total quantities of required chemicals may be reduced. In addition, it may well be found that some of those agents tried in the static tests that showed only partial efficacy may evince improved performance in the vault.

It is recommended that one or more of the prototype vaults be tested under field use conditions with lower concentrations of the selected agents, and with some additional agents that may be chosen out of further deliberation on the results of this program. Contact has been made with a company in the Los Angeles area engaged in the supply and servicing of portable toilets to construction jobs and other temporary requirements. It is quite feasible to arrange to set one or more of the vaults in the field and follow their performance under continued use by a variety of people. In such testing, then, preferred agents and effective concentrations could be determined, as well as the effects of recirculation mixing, ventilation, and other variables.

Further, with regard to the sanitary vaults, additional studies should be conducted on configuration and less costly materials and methods of construction. It is thought that an oval cross-section would lead to more strength, thus requiring thinner or cheaper materials and better performance. Such cross-section would permit the use of roll-up fabrication techniques with metals, or blow-molding or other fabrication methods with plastics or reinforced plastics. Furthermore, the oval shape would tend to direct flow of contents to the bottom center of the tank, and eliminate the possibility of pile-up of dry solids in the center, which may happen with the flat-bottomed present design.

Finally, in considering facilities in general, the thought has been expressed that in many fallout shelter housings that may be available, such as hotel basements, for example, existing flush toilet facilities may be usable. However, to make this practicable, water must be available. Such water may be found in sufficient quantity simply in the storage capacity of the building piping and service equipment, such as boilers, etc. Water use would necessarily have to be minimized, and fluid flow-hydraulic studies should be done on the minimum quantity of water that is required to make a conventional flush toilet operable.

In order to develop better specifications for sanitary and odor control agents, which would permit the introduction of other materials by a variety of suppliers, additional studies are needed to establish the controlling criteria for performance. Further elaboration of the screening tests, as described in this report, is needed. Other indices would be useful.

A suggested approach would be the use of off-gas analyses as related to agent performance. It may very well be possible to get pertinent information from analysis of the atmosphere in and around the sanitary vault by use of techniques such as gas chromatography and/or infra red spectrophotometry. Analysis for such constituents as ammonia, amines, hydrogen sulfide or mercaptans, carbon dioxide and methane, may lead to a correlation with the subjective performance criteria. Experiments could be devised using the sanitary vaults in field testing, or perhaps by setting up laboratory fermentation units, such as those employed in some types of sewage studies.

More intensive bacteriological studies are required in order to establish more definitive criteria for sanitary control. To date, the only bacteriological control index has been the presence or absence of the coliform organisms. The destruction of the more commonly expected pathogens and viruses would be of considerable importance in maintaining the health of the mixed occupancy population. The efficacy of the chemical control agent in this respect should be investigated, and, if possible, criteria should be established.

Some additional work could be done on packaging, again after better selection of the preferred sanitizing agent. The use of, say, high density polyethylene, which could be provided in extruded tubing, might be an improved substitute for the laminated sheet stock presently being considered.

Finally, the effects of the physiological processes on the performance of the system might be elaborated further. It is obvious that diet and water intake, as pointed out in the discussions in the earlier work (loc cit), will have an important bearing on the volume, consistency and odor of the excreted wastes. The disposal into the container of vomit, food scraps, sanitary napkins, and similar items, will further affect functioning of the system.

While the general care and feeding of the fallout shelter occupants is not within the purview of this project, the waste handling system must of necessity be integrated with other controlling factors. It is well known that, under normal conditions, the passage of solid foods through the alimentary tract takes several days, so that the first few days that occupants are in the shelter will produce a wide variation in excretion composition. At tne same time, the general psychological upset, associated with an emergency, will undoubtedly lead to intestinal disturbances, such as diarrhea, which will affect the excretion pattern. On the other hand, extended subsistence on the concentrated fallout shelter food supply, coupled with limited water intake, will probably result in much decreased fecal excretion, with associated dryness, plus decreased urine output, and these factors again will affect the performance of the waste system.

While the processing of large volumes of highly diluted human and industrial wastes has been well developed by the profession of sanitary engineering, knowledge in the handling and disposal of human wastes in concentrated form, under emergency conditions, is extremely limited. This aspect of sanitation certainly needs much more investigation.

APPENDIX I

Test Methods and Procedures

Laboratory Screening Tests.
Each chemical agent, as listed in Table I, Appendix II, was prepared in the concentrations indicated.

One ml. of base solution of concentration (c) in g/100 ml. times 10^2 gives the final concentration in 100 ml. total volume of excreta mixture plus sterilant in ppm. Thus, to obtain a required concentration in any particular mix, of X,000 ppm, use 10X/c ml. of base solution. This amount of base solution was added to a 250 ml. Erlenmeyer flask, and sufficient excreta mixture was then added to bring the total volume to approximately 100 ml.

The excreta used for the tests were collected in the following manner:

First Series. The urine, in a total volume of about 3.5 liters, was collected over a period of several hours from a mixed male population. It is believed, as pointed out in the discussion, that this procedure led to substantial urea hydrolysis, with resulting high pH, and consequent inhibition of coliform growth in the Smith tubes. The feces used were provided from four stools collected from four individuals without any specific regard to diet or other personal consideration. These were collected in wide mouth one pound screw cap jars, and were stored in the refrigerator until used.

Second Series. The urine in this case was collected in a total volume of about 2.0 liters, but in small increments, each increment being stored under refrigeration until the total was obtained. The pH of the resulting mixture in the second series was about normal, viz., 7.3. In this case, only two stools were collected.

The excreta mixtures for each series were made up in composition as shown in Table I (loc cit), thoroughly macerated and mixed.

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As pointed out in the discussion, if the Smith Tube Test is to be used as more than a very rough screening procedure for potential chemical agents, further refinement of the conditions and methods will be necessary.

After preparing the excreta mixture and sterilant for each case in the flasks, approximately 15 ml. was transferred to a Smith Fermentation Tube, to which was then added 0.5 ml. mineral oil. To the remainder of the mixture in each of the flasks was added 1.0 ml. of mineral oil. Tubes and flasks were incubated at 30°C.

Tubes and flasks were examined at intervals of 1, 2, 5, 7, and 12 days. Tubes were observed for gas formation, and the flasks were inspected subjectively for odor. For all tubes that showed no gas formation at the end of 2, 7, and 14 days, plates were made from the corresponding flasks, for both aerobes and anaerobes, at dilutions of 10^{-1}, 10^{-3}, 10^{-5}. Standard APHA methods and media were used. For base comparison, plates were run on the controls at 0, 2, 7, and 12 days.

Privy Tests.

A plywood privy, described and illustrated in report on previous work (loc cit) was set up to house the commode drums. In these tests, however, the air was not recirculated, but was ventilated on a once-through basis. Inasmuch as the commode drums are about 22 inches high, a foot rest was provided to permit comfortable posture. A recording hygrothermograph was installed on a shelf inside the privy and charts were changed daily except over weekends. These charts provided a continuous record of temperature and relative humidity conditions during the entire test period. The same records were used for storage conditions, inasmuch as storage was in an area immediately adjacent to the privy. Two similar units were installed, as mentioned in the discussion, one at Truesdail Laboratories and one at Applied Biological Sciences Laboratories.

APPENDIX I

Test Methods and Procedures

Each unit was supplied with a log sheet for each test, on which were recorded the time and nature of each useage. In general, four to five days were required to get a fill to greater than 80%.

For each separate test, a new drum, fitted with a double 4 mil polyethylene liner, was installed in the privy. To the drum was added one quart of water in which was dissolved the initial charge of sanitizing chemical, and one pint of vapor barrier oil was added. Further additions of chemical were made at fill levels of approximately 1/4, 1/2, and 3/4 full. At the end of the test period, the liners were tied, and the drums stored for 14 days.

Before each additional charge of chemical was made, a sample of the drum contents was removed for Smith Tube Test, coliform test, and organoleptic analysis. The sample was collected by means of a Pyrex glass, bulb-operated kitchen "roast baster". The tip of the baster was inserted two to three inches below the surface of the mixture in the drum. Sample size was 50 to 100 ml. However, procedures were slightly different at the two locations: At Truesdail, the contents were thoroughly stirred before the [illegible] was taken, while at Applied Biological Sciences, the sample was taken without stirring.

Frequently, during the test period, subjective observations were made of the privy environment, internally and externally, and several of the users were queried about their reactions tr odors. At the conclusion of the filling period a final sample taken, then the plastic drum liner was tied shut with a wire wrap, the lid was placed on the drum, and the drum was stored next to the privy. The storeo drums were observed at intervals during the storage period for odor in the area, gross gas formation as evidenced by any ballooning of the tied liner, or drum failure. At the end of the storage period, each drum was sampled again, and the samples were subjected to the Smith Tube and coliform tests.

APPENDIX I

Test Methods and Procedures

All bacteriological testing was done by Standard APHA Methods, using the five tube lactose broth method for presumptive coliforms, and confirming by five tube Brilliant Green Bile method. No plate counts were run on the privy test samples.

TABLE I

Laboratory Screening Tests

First Series

Group	Agent	Base Soln. g/100 ml.	pH	Test No.	Excreta Test Mixture[1] Concn. Agent, ppm. a.	b.	c.
I	a. Copper Sulfate Pentahydrate	10	0.7	1	1,000	2,000	
	b. Sodium Bisulfate	20		2	2,000	4,000	
				3	4,000	8,000	
II	a. Boric Acid	9	5.8	4	2,000	667	
	b. Sodium Perborate	3		5	4,000	1,333	
				6	8,000	2,667	
III	a. Saponified Cresylic Acids	10	9.1	7	500		
				8	1,000		
				9	2,000		
IV	a. Copper Sulfate Pentahydrate	5	0.9	10	500	1,000	300
	b. Sodium Bisulfate	10		11	1,000	2,000	600
	c. Sodium Perborate	3		12	2,000	4,000	1,200
V	a. Sodium Bisulfate	40	0.3	13	4,000		
				14	6,000		
				15	12,000		
VI	a. Saponified Cresylic Acids	5	9.3	16	500	300	
	b. Sodium Perborate	3		17	1,000	600	
				18	2,000	1,200	
VII	a. Zinc Sulfate	10	0.4	19	1,000	2,000	
	b. Sodium Bisulfate	20		20	2,000	4,000	
				21	4,000	8,000	
VIII	a. Sodium Bisulfate	20	0.4	22	2,000	1,000	
	b. Sodium Nitrate	10		23	4,000	2,000	
				24	8,000	4,000	
IX	a. Sodium Bichromate Dihydrate	5	0.8	25	500	1,000	
	b. Sodium Bisulfate	10		26	1,000	2,000	
				27	2,000	4,000	
X	a. MIL-D-51061	10	11.5	28	1,000		
				29	2,000		
				30	4,000		
XI	Control			31	With Mineral Oil		
				32	Without Mineral Oil		
				33	Without Dextrose or Mineral Oil		

(1) Excreta Mixture: Feces, 320 g.; Urine, 3,200 g.; Dextrose 32 g.

TABLE I

Laboratory Screening Tests

Second Series

Group	Agent	Base Soln. g/100 ml.	pH	Test No.	Excreta Test Mixture(1) Concn. Agent, ppm. a.	b.	c.
I	a. Copper Sulfate Pentahydrate	10		35	2,000	6,000	
	b. Sodium Bisulfate	30		37	4,000	12,000	
	a. Copper Sulfate Pentahydrate	10		36	2,000	8,000	
	b. Sodium Bisulfate	40					
II	a. Boric Acid	9		38	9,000	3,000	
	b. Sodium Perborate	3		40	18,000	6,000	
	a. Boric Acid	4.5		39	9,000	6,000	
	b. Sodium Perborate	3					
III	a. Saponified Cresylic Acids	10		41	4,000		
IV	a. Saponified Cresylic Acids	4		42	4,000	3,000	
	b. Sodium Perborate	3					
IX	a. Sodium Bichromate Dihydrate	10		43	2,000	8,000	
	b. Sodium Bisulfate	40		44	4,000	16,000	
X	a. MIL-D-51061	20		45	8,000		
XI	Control			46	As made up.		
				47	pH adjusted to 6.5.		

(1)Excreta Mixture: Feces, 150 g.; Urine, 1,500 g.; Dextrose 15 g.

TABLE II

Laboratory Screening Tests

Smith Tubes, Flasks, Plate Counts[1]

Day	1		2		5		7		12		2	8	0	12	8[2]
Test No.	Gas ml.	Odor (3,4)	Gas ml.	Odor	Gas ml.	Odor	Gas ml.	Odor	Gas ml.	Odor	A An	A An	pH	pH	Coli-forms.
1	0.9	B	3.0	B	5.0	VB	5.0	B	4.7	F	9 7		6.2	8.2	
2	T(5)	B	T	B	T	B	0.4	B	0.6	F	8 8		5.2	6.5	
3	T	B	T	B	T	F	T	F	T	F	3 1	3 2	3.7	4.6	
4	0	F	0	B-A	0	F-A	0	F-A	0	B-A	8 5	9 6	7.9	8.4	
5	0	F	0	B-A	0	F-A	0	F-A	0	F	7 5	8 5	7.6	8.3	
6	0	F	0	F	0	F-A	0	F	0	G	6 5	6 5	7.5	7.9	-
7	T	B	T	E	T	B	T	B	0	VB	9 6	9 7	8.3	8.4	
8	T	B	T	F-CA	T	B-CA	T	B-CA	0	B	9 5	9 6	8.4	8.3	
9	0	F	0	F-CA-AO		F-CA-AO		F-CA	0	F-CA	8 5	8 5	8.6	8.3	-
10	1.4	B	0.5	B	0.2	B-A	0.3	B	4.0	VB	8 9		7.2	8.4	
11	1.6	B	3.8	B	5.5	F	6.0	B	5.5	F	8 8		6.5	8.3	
12	T	F	T	B	T	F	T	F	T	F	8 8	7 7	5.7	6.1	+
13	T	B	T	VB	0.1	B-S	0.2	B-S	Terinated		8 7		7.1		
14	2.5	B	0.2	B	0.1	B-S	0.3	B-S	Terminated		7 7		5.7		
15	3.5	F	7.0	B	1.0	B-S	1.1	B-S	Terminated		9 9		3.8		
16	T	F	0	F-A	0	F	T	B	0	B-S	9 7		8.6	8.4	
17	0	F	0	F	0	F	0	B-A	0	F-A	8 6	9 5	8.5	8.4	+
18	0	F	0	F-CA-AO		F-CA-AO		F-CA-AO		G	8 6	8 5	8.5	8.3	+
19	T	F	T	B-A	T	B-A	T	B	T	B	8 6		7.5	8.2	
20	0.5	B	0.1	F	T	F	0.1	B	0.1	B-A	7 6		6.4	8.2	
21	3.5	B	7.0	F	0.2	B	0.2	B	0.2	B-A	8 9		4.9	8.4	
22	T	F	T	F	0	B	0	B	Terminated		9 7	9 6	7.9		
23	T	G	T	F	0	B	0	B	Terminated		9 7	10 6	7.3		
24	0.5	B	0.1	F-A	1.0	F-A	3.5	B	Terminated		8 8		6.0		
25	T	F	T	F-A	T	B-A	T	B-A	T	B-A	9 7		8.4	8.7	
26	0	G-A	0	G-A	0	B-A	0	B-A	0	B	9 7	10 6	8.3	8.4	
27	0	G	0	F-A	0	B	0	B	0	B-S	8 5	8 7	7.7	8.4	+
28	0	F-A	0	F-A	0	F-A	0	F-A	0	F-A	5 6	5 5	8.7	8.6	
29	0	G	0	F-A	0	G-A	0	F-A	0	F-A	5 6	5 5	8.7	8.6	
30	0	G-A	0	F-A	0	G-A	0	F-A	0	F-A	5 5	5 5	8.8	8.7	-(6)
31	T	VB	T	VB	T	VB	T	VB	T	VB	9 7	10 7	8.4	8.4	-
32	T	VB	T	VB	T	VB	T	VB	T	VB	8 7	9 6	8.4	8.7	
33	0	VB	0	VB	0	VB	0	VB	0	VB					
34(7)			1.5	VB			1.2	VB							
35	T	F	T	F-R	T	B-R	T	B-R	0.1	F-R	6 6		4.8	4.9	
36	T	F-R	T	B-R	T	B-R	T	B-R	T	B-R	2 2	2 2	4.3	5.0	+
37	T	F-R	T	B-R	T	B-R	T	B-R	T	B-R	1 1	1 2	3.0	3.5	-
38	0	F	0	F-A	0	F	0	F-R	0	F-R	6 6		7.3	7.5	
39	T	F	0	G	0	B	0	F-R	0	B-S	6 6		7.7	7.8	
40	0.2	F	0.1	F	0	F	0	F-R	0	F	6 6		7.3	7.9	
41	0	F-CA-AO		G-CA-AO		G-CA-AO		G-CA	0	F	3 5	3 4	8.0	7.8	-
42	0	F	0	G-CA	0	G-CA	0	F-CA	0	F	3 5	3 4	8.2	8.2	-
43	0	F	0	F-A	T	B	T	VB	T	B	8 7		5.6	8.0	
44	T	VB-R	T	F	0.3	B-R	0.3	F-R	0.3	G	5 2	4 4	3.2	6.5	-
45	0	B-A	0	F-A	0	G-A	0	F-A	0	G	1 5	3 4	9.2	8.5	-(6)
46	T	VB-A	T	VB-A	1.5	VB-A	1.4	VB-A	1.5	VB	9 9	9 7	7.3	8.6	-(7)
47	0.2	VB-A	0.1	VB-A	0.3	VB	0.2	VB-S	0.2	VB	7 7	7 7	6.6	8.7	(8)
48	T	VB-A	T	VB-A	T	VB	T	VB	T	VB	7 6		7.3	8.5	(9)
49	0.1	VB	0.1	VB-A	0.1	VB	0.1	VB-S	0.2	VB	6 7		6.6	8.5	(10)
50	0	VB-A	0	VB-A	0	VB	0	VB	0	VB	7 6		6.5	8.4	

NOTES:
1. Plate counts for aerobes and anaerobes. Numbers indicate exponents of 10.
2. Coliforms checked after 8 days and confirmed by BGB method.
3. Odor Scale: Good, Fair, Bad, Very Bad.
4. Odor Designation: A=Ammoniacal; CA=Cresylic Acid; R=Rancid; S=Sulfurous.
5. T = Trace.
6. Zero day count on control: A, 8; An, 8. 20 hour coliform +.
7. Control with pH adjusted to 6.5.
8. Test 46 with vegetable oil layer.
9. Test 47 " " " " .
10. Control, no glucose added.

APPENDIX II

TABLE III

Proposed Privy Tests

Group No.	Agent	Concentration, ppm. a.	b.	Test Nos.
I	a. Copper Sulfate Pentahydrate	4,000	8,000	1,2 (1)
	b. Sodium Bisulfate	4,000	12,000	3,4
II	a. Boric Acid	9,000	6,000	5,6 (2)
	b. Sodium Perborate	18,000	6,000	7,8 (2)
III	a. Saponified Cresylic Acids	2,000		9,10
VI	a. Saponified Cresylic Acids	4,000	3,000	11,12 (2)
	b. Sodium Perborate			
IX	a. Sodium Dichromate Dihydrate	4,000	16,000	13,14
	b. Sodium Bisulfate			
X	a. MIL-D-51061	1,000		15,16 (2)
	(Spec. Dosage 1,000 ppm.)	2,000		17,18
XI	a. Dow-ET-542	1,000		19,20
	b. Sodium Bisulfate	1,000	4,000	21,22
XII	a. Dow-ET-830	2,500		23,24
	b. Sodium Bisulfate	5,000	4,000	25,26
I	a. Copper Sulfate Pentahydrate	4,000	4,000	27,28
	b. Sodium Bisulfate	4,000	8,000	29,30 (3)
		8,000	8,000	31,32
		8,000	8,000	33,34 (4)
		4,000	8,000	35,36 (5)
		4,000	8,000	37,38 (6)
XII	a. Dow-ET-830	5,000	8,000	39,40
	b. Sodium Bisulfate			
X	a. MIL-D-51061	4,000		41,42
XIII	a. Copper Sulfate Pentahydrate	4,000	8,000	43,44 (7)
	b. Sodium Bisulfate			
XIV	a. Copper Sulfate Pentahydrate	4,000	8,000	45,46
	b. Sodium Dihydrogen Phosphate			
I	a. Copper Sulfate Pentahydrate	4,000	4,000	47,48 (6)
	b. Sodium Bisulfate			

NOTES:

1. Each pair of tests is a set of duplicates, one run at Truesdail, the other at Applied Biological Sciences.
2. Tests Nos. 6,7,8,11,12 were skipped, as it appeared that the Perborate was not very effective. Nos. 15 and 16 were run later.
3. All tests through No. 28 were run with mineral oil as a vapor barrier. Subsequent tests used Oleic Acid (Red Oil) as a replacement.
4. The ventilation system was changed to downflow instead of upflow.
5. Plus one lb. of Dimethyl Sulfoxide (DMSO).
6. Plus 1,000 ppm Dowfax 9N9 Surfactant.
7. Added 4,000 ppm Sodium Dichromate Dihydrate as an oxidant.

APPENDIX II

TABLE IV

Privy Use Record

Test No.	Date From-to	Hrs. Tot.	Hours when Agent added	Fill %	Contributions U	Contributions D	Odor at fill level 1/4	1/2	3/4	1/0	14 Day	Comments
1	5/25-28	80	0,8,32,56	80	100	20	G	F	F	F	F	Acceptable
2	5/25-6/2	199	0,53,175	65	80	16	G	F	F		F	"
3	6/1-3	79	0,7,31,55	75	93	21	G	G	G	G	B	"
4	6/3-10	179	0,33,58,130	100	143	29	G	G	G	G	G	"
5	6/8-11	74	0,8,32,56	65	84	25	F	B	VB	VB	VB	After three days not acceptable.
9	6/15-18	79	0,8,32,56	80	99	22	F	F	F	F	B	Cresol odor.
10	6/15-19	106	0,11,35,83	100	168	30	G	G	G	G	F	" "
13	6/22-26	96	0,8,32,56	90	97	26	B	F	B	VB	VB	
14	6/22-26	106	0,28,53,76	100	179	28	G	G	F	F	B	
17	6/29-7/2	80	0,8,32,56	75	101	28	F	F	F	B	B	Strong ammonia odor.
18	6/29-7/2	83	0,29,53	75	152	19	F	F	F		B	" " "
19	7/6-10	97	0,24,48,71	80	109	23	G	F	B	B	B	" " "
20	7/6-10	106	0,28,53,79	80	142	20	B	B	B	B	B	" "
21	7/13-17	95	0,23,48,72	70	90	24	B	B	VB	VB	VB	
22	7/13-17	106	0,29,77	65	139	11	B	B	B		VB	
23	7/20/24	99	0,8,31,55	75	100	18	F	F	B	B	B	
24	7/20-24	105	0,31,64	70	115	13	G	B		B	B	
25	7/27-30	80	0,25,49,73	65	98	28	G	B	B	B	B	
26	7/27-31	106	0,28,57	65	94	13	G	F		F	F	Acceptable
27	8/3-7	97	0,24,49,73	80	103	30	B	B	B	B	B	
28	8/3-7	105	0,30,76	75	126	15	F		F	F	F	Acceptable
29	8/10-13	80	0,24,49,72	100	103	27	B	B	B	B	B	
30	8/10-14	106	0,31,75	75	115	13	F		G	G	F	Acceptable
31	8/17-21	97	0,24,48,74	90	88	19	F	F	F	F	B	"
32	8/17-21	97	0,52,65	65	76	10		G	G	F	B	"
33	8/24-28	104	0,24,49,72	90	137	35	G	F	F	B	B	
34	8/24-28	107	0,26,53	70	110	15	B	B		VB	VB	
35	8/31-9/4	97	0,24,51,75	75	105	19	B	B	F	F	VB	DMSO has very penetrating odor of its own.
36	8/31-9/4	103	0,26,71	65	120	13	B	B		VB	VB	" " " "
15	9/14-18	98	0,25,53,75	60	115	22	B	B	B	B	VB	Strong ammonia odor
16	9/14-17	81	0,26,53,81	75	140	16	G	G	F		VB	" " "
37	9/21/25	103	0,24,50,72	80	118	36	F	F	F	F	B	Acceptable
38	9/21-25	105	0,27,52,77	90	141	16	G	G	F	F	F	"
39	9/28-10/2	102	0,25,49,73	80	130	33	B	B	B	B	B	
40	9/28-10/2	105	0,26,50,71	90	137	14	G	F	F	G	F	Acceptable
41	10/5-9	103	0,24,49,73	80	118	39	B	B	B	B	B	
42	10/5-9	104	0,30,73,97	90	136	12	G		G	F	VB	Acceptable
43	10/12-16	97	0,24,49,72	70	100	20	B	B	B	B	B	Rancid
44	10/12-16	104	0,28,73	80	118	13	F		F	F	F	Acceptable
45	10/19-23	97	0,23,52,71	65	80	16	G	G	G	G	F	"
46	10/19-23	104	0,26,51,77	75	119	17	G	F	G	F	B	"
47	10/26-30	98	0,24,49,72	80	120	19	G	G	G	G	B	"
48	10/26-30	104	0,27,53,78	100	132	9	G	G	G	G	F	"

NOTES:

1. U=urinations; D=defecations.
2. Odor scale: Good, Fair, Bad, Very Bad.

Truesdail Laboratories, Inc. 30 May, 1965.

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APPENDIX II

TABLE V

Privy Tests - Bacteriological Examinations

Test No.	1	2	3	4	5	9	10	13	14	17	18	19	20	21	22	23	24	25	26	27	2[illegible]
Sample,Hrs.	8	53	7	33	8	8	11	8	28	8	29	24	28	23	29	8	31	25	28	24	3[illegible]
pH	2.2	4.5	1.8	4.5	8.0	8.6	7.6	1.8	3.0	7.0	8.8	7.7	8.8	4.2	2.9	6.7	7.1	5.9	2.8	3.6	2.[illegible]
STG,cc. Day 1	0	0	0	0	0.5	0	0	0	0	0	0	0	0	T	0	0	0	0	0	0	[illegible]
5	0	0	0	0	0.4	0	0	T	T	0	0	0	0	T	0	0	0	0	0	T	[illegible]
9	0	0	0	0	0.5	0	1.0	T	0.5	0	0	0	0.5	T	0	0	0	0	0	T	[illegible]
14	0	0	0	0	0.5	0	1.5	T	1.0	0	0	0	1.0	T	0	0	0	0	0	T	[illegible]
PC	-	-	-	-	5+	-	5+	-	-	3+	-	5+	5+	5+	3+	5+	5+	5+	-	4+	-
CC	-	-	-	-	5+	-	-	-	-	3+	-	5+	5+	5+	3+	5+	2+	5+	-	4+	-
Sample,Hrs.	32	98	31	58	32	32	35	32	53	32	53	48	53	48	56	31		49	57	49	
pH	2.0	4.7	1.7	4.6	7.6	8.1	7.7	2.2	5.0	8.2		7.9	8.0	6.6	3.2	8.3		7.3	2.7	4.3	
STG,cc. Day 1	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0		0	0	0	
5	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0		0	0	T	
9	0	1.0	0	0	0.1	0	0	T	0.5	0	0	0	0	0	0.5	0		0	0	T	
14	0	3.0	0	0	0	0	0	T	1.5	0	0	0	0	0	0.5	0		0	0	T	
PC	-	-	-	-	5+	1+	-	1+	-	5+	-	5+	5+	5+	3+	5+		5+	-	4+	
CC	-	-	-	-	5+	-	-	-	-	-	-	5+	4+	5+	1+	5+		5+	-	3+	
Sample,Hrs.	56	175	55	130	56	56	83	56	76	56	81	73	79	72		55	73	73		73	76
pH	2.1	4.5	2.1	4.5	7.6	8.6	8.0	2.5	4.5	8.3	8.8	8.0		6.9		8.4	8.8	8.1		5.2	2.5
STG,cc. Day 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0		0	0
5	0	0	0	0	0	0	0	T	0	0	0	0	0	0		0	0	0		T	0
9	0	0	0	0	0	0	0	T	T	0	0	0	0	0		0	0	0		T	0
14	0	2.0	0	0	0	0	0	T	0.5	0	0	0	0	0		0	0	0		T	0
PC	-	-	5+	2+	5+	1+	-	-	2+	5+	-	5+	4+	4+		5+	5+	1+		5+	-
CC	-	-	5+	-	5+	-	-	-	-	-	-	5+	4+	5+		5+	1+	1+		5+	-
Sample,Hrs.	80	199	79	179	74	79	106	96	106	80		97	106	95	106	99	105	80	106	97	105
pH	2.2		2.0	4.7		8.4	8.0	3.2	4.5	8.4		8.0	8.2	7.2	4.0	8.5	8.5	8.3	2.7	5.4	2.5
STG,cc. Day 1	0	0	0	0	0	0	0	T	0	0		0	0	0	0	0	0	0	0	T	0
5	0	0	0	0	0	0	0	T	0	0		0	0	0	0	0	0	0	0	T	0
9	0	0	0	0	0	0	1.0	T	0.5	0		0	0	0	0	0	0	0	0	T	0
14	0	0	0	0	0	0	2.0	T	1.0	0		0	0	0	0	0	0	0	0	T	0
PC	-	-	-	5+	-	5+	5+	4+	5+	5+		5+	5+	5+	3+	5+	5+	1+	-	5+	-
CC	-	-	-	-	-	-	-	-	-	-		5+	4+	5+	3+	5+	1+	-	-	5+	-
Sample,Day	14	14	14	14	7	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
pH	2.5	4.5	2.3	4.5	7.9	8.6	8.0	5.4	4.0	9.0	8.6	8.5	8.5	8.4	8.7	8.7	8.3	8.2	2.7	6.2	3.3
STG,cc. Day 1	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	T	0
5	0	0	0	0.5	0	0	0.5	0.1	0.5	0	0	0	0	0	0	0	0	0	0	T	0
9	0	0	T	1.0	0	0	2.0	0.1	0.5	0	0	0	0	0	0	0	0	0	0	T	0
14	0	0	T	2.0	0	0	3.0	0.1	0.5	0	0	0	0	0	0	0	0	0	0	T	0
PC	-	-	1+	5+	5+	5+	1+	5+	5+	5+	3+	5+	5+	5+	4+	5+	5+	5+	-	5+	-
CC	-	-	1+	5+	5+	-	-	5+	-	-	-	5+	5+	-	-	-	2+	-	-	5+	-

NOTES: STG = Smith Tube Gas; PC = Presumptive Coliforms; CC = Confirmed Coliforms.

27	28	29	30	31	32	33	34	35	36	15	16	37	38	39	40	41	42	43	44	45	46	47	48
4	30	24	31	24		24	26	24	26	25	26	24	27	25	26	24	31	24	28	23	26	25	27
.6	2.4	3.0	2.3	2.5		2.4	3.5	2.4	2.7	7.4	8.5	2.1	2.8	3.8	2.0	6.6	7.2	2.6	3.3	3.4	4.4	2.9	2.6
0	0	T	0	0		T	0	T	0	0	0	T	0	0.5	0	0.3	0	T	0	0	0	0	0
T	0	T	0	0		T	0	T	0	0	0	0	0	0	0	0.1	0	T	0	0	0	0	0
T	0	T	0	0		T	0	T	0	0	0	T	0	0	0	T	0	T	0	0	0	0	0
T	0	T	0	0		T	0	T	0	0	0	0	0	T	0	T	0	T	0	0	0	0	0
+	-	-	-	-		-	-	-	-	5+	2+	-	-	5+	-	5+	-	1+	-	-	-	-	-
+	-	-	-	-		-	-	-	-	5+	1+	-	-	5+	-	5+	-	-	-	-	-	-	-
9		49		48	52	49	53	51		53	53	50	56	50	56	49		49		52	51	49	53
.3		3.7		2.9	3.7	2.4	4.0	2.8		8.6	8.5	2.0	3.5	5.7	2.2	8.0		3.1		4.3	4.6	3.7	3.0
0		0		0	0	T	0	T		0	0	0	0	0.2	0	0		T		0	0	T	0
T		T		T	0	T	0	T		0	0	0	0	0	0	0		T		0	0	T	0
T		T		T	0	T	0	T		0	0	T	0	0	0	0		T		0	0	T	0
T		T		T	0	T	0	T		0	0	T	0	0	0	0		T		0	0	T	0
+		5+		-	-	-	-	-		5+	2+	-	-	5+	-	-		-		5+	-	-	-
+		5+		-	-	-	-	-		5+	3+	-	-	5+	-	-		-		5+	-	-	-
3	76	72	75	74	65	72		75	71	75	81	72	81	74	79	73	74	72	72	71	77	72	78
.2	2.5	4.0	2.4	3.3	2.0	3.1		3.0	4.0	8.6	8.6	2.2	3.0	6.5	2.0	8.5	8.7	4.2	4.0	5.2	5.2	4.0	2.8
0	0	0	0	T	0	T		T	0	0	0	0	0	0	0	0	0	T	0	T	0	T	0
T	0	T	0	T	0	T		T	0	0	0	T	0	0	0	0	0	T	0	T	0	T	0
T	0	T	0	T	0	T		T	0	0	0	T	0	0	0	0	0	T	0	T	0	T	0
T	0	T	0	T	0	T		T	0	0	0	T	0	0	0	0	0	T	0	T	0	T	0
+	-	5+	-	-	-	-		-	-	5+	3+	-	-	5+	-	-	-	-	-	5+	1+	1+	-
+	-	5+	-	-	-	-		-	-	5+	3+	-	-	5+	-	-	-	-	-	5+	-	1+	-
7	105	80	1-6	97	97	104	97	97	103	98		103	105	103	103	103	97	97	104	97	104	98	104
4	2.5	3.7	2.6	3.5	2.2	4.1	5.0	2.8	5.0	8.5		2.5	3.0	6.9	2.1	8.3	8.8	4.8	3.8	5.7	5.6	4.5	3.0
T	0	0	0	T	0	T	0	T	0	0		0	0	0	0	0	0	T	0	0.4	0	T	0
T	0	T	0	T	0	T	0	T	0	0		T	0	0	0	0	0	T	0	0.4	0	T	0
T	0	T	0	T	0	T	0	T	0	0		T	0	0	0	0	0	T	0	0.4	0	T	0
T	0	T	0	T	0	T	0	T	0	0		T	0	0	0	0	0	T	0	0.3	0	T	0
+	-	2+	4+	-	-	-	-	-	1+	5+		-	-	5+	-	-	5+	-	-	5+	5+	3+	-
+	-	2+	3+	-	-	-	-	-	-	5+		-	-	5+	-	-	3+	-	-	5+	5+	3+	-
4	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
2	3.3	4.7	3.3	3.7	3.0	5.3	4.1	2.6	3.3	8.6	8.0	3.8	3.8	8.4	2.4	8.7	8.8	5.8	4.3	5.9	2.5	5.7	6.8
T	0	T	0	T	0	T	0	T	0	0	0	0	0	0	0	0	0	T	0	0.5	0	T	0
T	0	T	0	T	0	T	0	T	0	0	0	0	0	0	0	0	0	T	0	0.5	0	T	0
T	0	T	0	T	0	T	0	0	0	0	0	0	0	0	0	0	0	T	0	0.3	0	T	0
T	0	T	0	T	0	0	0	0	0	0	0	0	0	0	0	0	0	T	0	0.2	0	T	0
+	-	5+	5+	-	4+	-	4+	-	-	-	5+	5+	-	-	-	-	5+	5+	-	5+	5+	4+	-
+	-	5+	5+	-	4+	-	4+	-	-	-	5+	5+	-	-	-	-	5+	5+	-	5+	5+	4+	-

B

APPENDIX II

TABLE VI

Record of Privy Tests and Conditions

Test No.	Date Start	Hrs. Tot.	Conditions Inside Privy Daytime Only: Temp. °F Hourly(1)			Conditions Inside Privy Daytime Only: RH,% Hourly(1)			Local Weather, Los Angeles: Temp. °F			Los Angeles: RH,%			Lockheed: Temp. °F			Lockheed: RH,%		
			Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Noon Avg	Max	Min	Avg	Max	Min	Noon Avg
1	5/25	80		NOT RECORDED(2)					83	53	64	84	20	45						
2	5/25	175(3)		"		"									84	47	63	90	20	44
3	6/1	79		"		"			73	55	64	91	47	57						
4	6/3	179(3)		"		"									77	51	63	96	47	59
5	6/8	74 (4)	75	63	68	67	54	60	73	52	61	99	43	56						
9	6/15	79	76	66	65	68	59	66	73	56	62	97	49	69						
10	6/15	106	74	68	68	64	56	60							75	52	63	90	48	64
13	6/22	96	80	66	68	70	64	65	82	56	67	99	40	54						
14	6/22	106	83	70	75	63	52	59							99	54	72	96	23	40
17	6/29	80	83	68	77	62	42	55	85	55	70	93	14	29						
18	6/29	83	84	70	75	53	9	35							89	49	70	80	12	23
19	7/6	97	80	70	74	70	58	63	84	58	70	98	31	45						
20	7/6	106	88	72	78	59	38	48							93	54	73	90	26	40
21	7/13	95	86	75	81	67	59	65	88	60	72	97	38	47						
22	7/13	106	90	72	82	64	40	52							96	60	76	93	30	41
23	7/20	99	84	72	78	69	63	66	83	60	69	91	39	47						
24	7/20	105	86	74	80	58	39	52							95	61	78	97	30	44
25	7/27	80	84	75	80	70	62	64	86	62	74	89	37	46						
26	7/27	106	92	77	84	55	37	48							95	61	78	87	27	40
27	8/3	97	84	74	78	68	62	67	87	63	75	87	45	53						
28	8/3	105	88	74	82	58	42	49							93	59	77	97	23	40
29	8/10	80	85	76	78	71	66	68	85	65	75	87	54	59						
30	8/10	106	88	77	83	61	50	56							86	64	75	93	53	60
31	8/17	97	84	74	79	72	62	67	86	61	74	90	39	51						
32	8/17	97	86	75	81	66	44	56							92	57	76	97	26	51
33	8/24	104	84	73	78	72	65	68	89	64	74	90	47	50						
34	8/24	105	90	82	85	63	44	57							95	63	76	100	32	54
35	8/31	97	79	67	74	68	57	63	85	58	70	87	23	46						
36	8/31	103	88	75	80	60	36	51							89	51	73	90	17	42
15	9/14	98	78	65	73	73	56	64	79	58	68	90	52	59						
16	9/14	81	88	70	81	68	54	57							83	57	68	97	44	55
37	9/21	103	80	66	75	72	56	65	92	57	74	97	27	42						
38	9/21	105	91	76	84	64	36	45							97	53	74	90	13	33
39	9/28	102	78	63	71	73	64	69	78	63	71	73	64	69						
40	9/28	105	86	74	80	66	57	61							86	51	68	100	14	40
41	10/5	103	84	71	79	68	60	65	94	61	77	93	24	43						
42	10/5	104	95	74	85	68	43	54							100	57	78	84	20	31
43	10/12	97	76	64	71	78	65	71	77	58	67	96	50	60						
44	10/12	104	86	69	82	74	56	61							84	57	68	97	41	53
45	10/19	97	80	63	74	76	50	59	96	58	74	90	12	39						
46	10/19	104	91	80	85	60	28	39							96	53	71	90	9	33
47	10/26	98	76	62	73	72	48	59	77	52	65	93	46	57						
48	10/26	104	80	72	78	68	54	60							78	49	63	93	37	55

NOTES:

1. Averages for daytime use period taken from hourly chart records, 0800 to 1700 hours.
2. Recorder had not arrived.
3. Sat over three day weekend.
4. Terminated - not satisfactory.

APPENDIX II

TABLE VII

Storage Conditions (5)

Test No.	Date Start	Days Tot.	Recorded Temp. °F Daily(6) Max	Min	Avg	Recorded RH,% Daily(6) Max	Min	Avg	Local Weather Los Angeles Temp. °F Max	Min	Avg	Los Angeles RH,% Max	Min	Noon Avg	Lockheed Temp. °F Max	Min	Avg	Lockheed RH,% Max	Min	Noon Avg
1	5/28	21	NOT RECORDED(7)						76	52	62	99	43	57						
2	6/2	14	"			"									80	47	63	96	44	58
3	6/4	14	"			"			76	52	62	99	43	57						
4	6/10	14	"			"									84	47	64	96	40	56
5	6/11	7	"			"			76	54	64	97	49	61						
9	6/18	14	84	64	73	70	40	61	85	55	67	99	14	53						
10	6/19	14	89	70	76	63	8	47							99	49	69	96	12	41
13	6/26	14	84	64	72	72	40	59	89	55	70	98	14	41						
14	6/26	14	90	70	79	62	38	42							93	49	71	93	12	32
17	7/2	14	86	66	78	72	46	63	87	57	72	98	25	46						
18	7/2	14	91	72	80	65	36	48							96	53	74	90	22	36
19	7/10	14	86	69	78	70	55	64	89	59	72	97	27	46						
20	7/10	14	91	72	82	65	36	50							96	59	75	97	27	40
21	7/17	14	84	68	77	70	55	64	86	59	72	96	37	48						
22	7/17	14	92	74	82	58	34	50							95	59	76	97	27	42
23	7/24	14	84	68	78	70	55	63	87	59	75	62	41	49						
24	7/24	14	92	74	83	64	34	53							95	59	78	97	23	43
25	7/30	14	85	68	78	72	60	66	92	62	76	62	41	53						
26	7/31	14	90	74	83	64	42	53							99	59	78	97	23	50
27	8/7	14	85	68	78	72	60	66	92	59	76	64	41	51						
28	8/7	14	89	73	82	65	42	55							99	54	77	97	23	49
29	8/13	14	84	68	77	72	58	66	89	59	75	64	43	54						
30	8/14	14	92	73	83	65	42	56							95	54	76	100	26	47
31	8/21	14	84	65	76	70	58	65	89	58	72	90	23	63						
32	8/21	14	92	75	83	63	34	54							95	51	72	100	17	47
33	8/28	14	84	65	73	70	36	59	92	58	71	90	23	45						
34	8/28	14	91	65	79	70	28	51							97	49	64	100	9	44
35	9/4	14	80	63	73	72	56	66	92	56	70	90	14	49						
36	9/4	14	91	65	79	68	28	61							97	49	71	100	9	45
15	9/18	14	80	62	72	74	56	67	92	55	70	90	27	54						
16	9/18	14	91	74	81	66	36	59							97	51	74	100	12	39
37	9/25	14	84	62	74	74	53	67	94	55	80	100	23	50						
38	9/25	14	95	74	82	70	37	60							100	51	73	100	12	35
39	10/2	14	84	66	73	74	53	67	94	58	71	97	23	51						
40	10/2	14	95	74	86	70	37	57							100	55	77	97	12	40
41	10/9	14	80	62	72	78	60	63	96	58	70	97	12	55						
42	10/9	14	92	70	83	63	28	53							96	53	70	97	4	44
43	10/16	14	80	60	69	78	48	63	96	52	68	96	12	53						
44	10/16	14	92	72	81	68	28	57							96	49	61	93	4	47
45	10/23	14	76	55	67	74	22	52	87	51	66	93	11	45						
46	10/23	14	81	72	77	68	54	62							85	47	63	93	9	45
47	10/30	14	76	55	65	58	22	46	87	45	59	93	11	54						
48	10/30	14	NOT RECORDED												85	44	60	100	9	47

NOTES:

5. Storage next to privy. Assume conditions recorded approximately same as inside privy.
6. Averages for storage made from daily recorded maxima and minima.
7. Recorder had not arrived.

APPENDIX II

TABLE VIII

Package Accelerated Storage Test Data

Sample No.	Material	Weight Change %	Observation
1	Dow #1	-0.59	Package ruptured, contents hard caked.
2	"	+1.9	Package ruptured, foil attacked, contents hard caked.
3	"	-0.30	Package ruptured, contents hard caked.
4	"	+0.92	Package ruptured, foil attacked, contents hard caked.
5	Dow #2	+0.50	Outside of package o.k., some attack on inside foil, contents hard caked.
6	"	-6.0	Package ruptured, loss of contents, remaining contents hard caked.
7	"	-2.9	Package ruptured, loss of contents, remaining contents hard caked.
8	"	-1.9	Package ruptured, loss of contents, remaining contents hard caked.
9	Dow #3	+0.26	Outside and inside of package o.k., contents soft caked.
10	"	+0.34	Outside of package o.k., inside not inspected, contents soft caked.
11	"	-1.5	Outside partially delaminated, no rupture, inside o.k., contents soft caked
12	"	-2.0	Outside partially delaminated, no rupture, inside not inspected.
13	Gusset		All of the gusset bag packs were quite soggy on the outside paper,
14	"		showed leakage of contents or rupture. The package was too bulky,
15	"		hard to fill, and warranted no further investigation.
16	"		
17	Dow #4	0.0	Outside and inside of package excellent, contents loose, but damp.
18	"	0.0	Outside and inside of package excellent, contents loose but damp.
19	"	0.0	Outside of package excellent, inside not inspected, contents soft caked.
20	"	0.0	Outside of package excellent, inside not inspected, contents soft caked.
21	Dow #5		All remaining samples failed by rupture and loss of contents.
22	"		"
23	"		"
24	"		"
25	Dow #6		"
26	"		"
27	"		"
28	"		"

APPENDIX III

I

Chemical Agent Specification Criteria

SPECIFICATION
SANITIZING AND ODOR CONTROL AGENT

1.0 SCOPE

This specification covers sanitizing and odor control agents for chemical treatment of human wastes in commode type containers.

Type I Inorganic chemical

Type II Chemical Agent (Specification data is provided as Exhibit A of this specification.)

2.0 REQUIREMENTS

2.1 Composition and Form. The sanitizing and odor control agent, Type I, shall consist of a mixture of two inorganic chemicals in granular, fine crystalline or globular form and shall conform to the composition in Table I.

TABLE I, COMPOSITION

Chemical	Percent by Weight	
	Min.	Max.
Copper sulfate pentahydrate	30.0	35.0
Sodium bisulfate	65.0	70.0

2.2 Copper Sulfate Pentahydrate. The copper sulfate pentahydrate shall be of technical grade, fine crystalline or granular, and shall assay not less than 99% pure minimum, shall contain not less than 25.0% copper, and water insolubles shall not exceed 0.5%

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Chemical Agent Specification Criteria

Size shall be specified as 10 mesh, and shall conform generally to the following typical size distribution or Standard Screen Analysis (USS Mesh):

On 10	0.0%
Through 10 on 30	98.0%
Through 30 on 60	1.9%
Through 60	0.1%

(See section on Sampling and Test Methods)

2.3 Sodium Bisulfate. The sodium bisulfate shall be of technical grade, globular, and shall assay not less than 92.0% sodium bisulfate, the remainder being sodium sulfate. Acidity as H_2SO_4 shall be not less than 38.0%.

Size distribution shall conform generally to the following typical Standard Screen Analysis (USS Mesh):

On 10	0.0%
Through 10 on 20	43.4%
Through 10 on 30	84.9%
Through 20 on 30	41.5%
Through 30 on 40	10.6%
Through 40 on 60	4.4%
Through 60 on 100	0.1%
Through 100	0.01%

(See section on Sampling and Test Methods)

2.4 Oleic Acid. The oleic acid shall be of technical grade, single distilled, designated on the commercial market as "red oil".

2.5 Finished Product. The finished sanitizing and odor control agent shall be a physical mixture of the two inorganic chemicals specified in Table I. The mixture need not be uniform in a single

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Chemical Agent Specification Criteria

package PROVIDED that the single package composition conforms to the requirements of paragraph 2.1, Table I.

The oleic acid shall be furnished as a separate adjunct material, packaged as specified below.

3.0 Packaging.

3.1 Packaging - Sanitizing Chemical.

3.11 Unit Package. Two sizes of unit package may be specified: (1) Not less than eight (8) ounces of chemical in a pouch with dimensions of 4.5 inches wide, top and bottom, by 6.0 inches long, ± 0.25 inch; (2) Not less than one (1) pound of chemical in a pouch with dimensions of 5.0 inches wide, top and bottom, by 8.0 inches long, ± 0.25 inch. Pouches shall be constructed of heat sealable barrier material of the following laminate structure: (Inside to outside) 0.0015 inch medium density polyethylene/ 0.00035 inch aluminum foil/ 10 lb. (ca. 0.0007 inch) polyethylene film/ 30 lb. glassine (cellulose acetate). The material shall not affect nor be affected by the contents being packaged. Pouches shall be of either one or two piece construction at option of contractor. Side, top and bottom seams of the two-piece pouch shall be heat sealed with the seals being a minimum of 3/8-inch in width. Packaging materials and packages shall conform to the requirements specified in Sections 4.4.7 to 4.4.7.4 and 5.1.1.1.1 to 5.1.1.1.6 of MIL-D-51061 (QMC).

3.12 Packing. Pouches shall be packed for shipment and storage in Type CF or SF, Style RSC, Variety SW, Class - weather-resistant Fiberboard boxes, as specified in Federal Specifi-

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Chemical Agent Specification Criteria

cation PPP-B-636c. The one-half pound pouches shall be random packed 100 to the box; the one pound pouches shall be packed 50 to the box.

3.13 Marking. Each pouch, depending on its capacity, shall have the following information printed legibly on the outside in permanent black or blue ink:

One-Half Pound Sanitizing and Odor Control Agent,

Type I

Dual Purpose Water Storage - Commode Drum 17.5 gal.

1. Initial charge - Add contents of one pouch (0.5 lb.) to one quart of water and pour contents into commode drum.
2. Add one pouch (0.5 lb.) dry chemicals to commode drum when 1/3 full and again when 2/3 full.

One Pound Sanitizing and Odor Control Agent,

Type I

Sanitary Vault Commode.

1. Initial charge - Add contents of one pouch (1.0 lb.) to 10 gallons of water in commode and dissolve by stirring or recirculating contents by means of pump.
2. Add two pouches (2.0 lbs.) dry chemical to commode when 1/4, 1/2, and 3/4 full.

CAUTION: Acid chemical.
Do not get in eyes, on skin or clothing.
Avoid inhaling dust.
Do not take internally.
In case of contact, wash contacted area with water.

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Chemical Agent Specification Criteria

If accidentally swallowed, chemical will cause nausea and vomiting. Induce vomiting if necessary.
Give large amounts of water. Get medical attention.
POISON: (Skull and Crossbones symbol).

3.2 Packaging - Oleic Acid.

3.21 Unit Package. The oleic acid shall be packaged in standard one gallon "F Style" cans, minimum 0.50 tin plate, or in one gallon polyethylene bottles.

3.22 Packing. Cans or bottles shall be packed, with dividers, in units of ten per box, in Type CF or SF, Style RSC, Variety SW, Class - weather-resistant Fiberboard boxes as specified in Federal Specification PPP-B-636c.

3.23 Marking. Each unit package shall have the following information printed legibly, by direct printing or labeling, on the outside in permanent black or blue ink:

Vapor Barrier-Odor Control Adjunct.
For use in OCD Dual Purpose Water Storage-Commode Drums, 17.5 gallons, or in Sanitary Vault Commodes.
Name and address of manufacturer.
Date of pack, lot No. Net weight or volume.
Directions:
1. Dual Purpose Water Storage-Commode Drums, 17.5 gallons - add one pint with initial charge of sanitizing chemical.
2. Sanitary Vault Commode -
Add one gallon with initial charge of sanitizing chemical.

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Chemical Agent Specification Criteria

CAUTION: Do not get in eyes, on skin or clothing.
Do not take internally.
In case of contact, wash contacted area with soap and water.

4.0 SAMPLING AND TEST METHODS.

4.1 Sampling I - Bulk sanitizing chemicals.

A single lot shall be limited to 40 tons for sampling purposes. If chemical is handled by conveyor, sampling shall be done by taking a single cut across the conveyor belt at intervals, taking about one pound per cut. If chemical is packaged in drums, a one pound sample shall be taken from the center of each drum sampled.

The gross sample shall be not less than 0.1% of the lot size, or in no case less than 20 lbs.

If the gross sample is greater than 40 lbs., it may be reduced to this amount by standard coning and quartering procedure or by means of standard riffling equipment.

The gross sample required for screen analysis shall be 5 lbs.

The gross sample required for chemical analysis shall be 10 lbs.

After such preparation, the gross sample shall be divided into at least five one-pound samples, an original and reserve for shipper and buyer, and a reserve for referee, if required.

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Chemical Agent Specification Criteria

Inasmuch as the copper sulfate pentahydrate is efflorescent, and the sodium bisulfate is deliquescent, all sampling should be done as rapidly as possible to prevent loss or gain of water in the atmosphere.

4.2 Sampling - II - Repackaged Chemicals in Pouches.

One pouch shall be removed at random from a minimum of 2% of cases comprising any one lot of maximum 40 tons. These pouches shall be opened and consolidated into one gross sample, which shall be thoroughly mixed in a mechanically driven tumble mixer in a dry atmosphere.

4.3 Chemical Analyses.

Samples taken from the chemical raw material lots shall be analyzed directly for their principal constituents:

Copper sulfate pentahydrate shall be analyzed for copper by the electrolytic method. Ref.: Scott; Standard Methods of Chemical Analysis, or similar standard reference.

Sodium bisulfate shall be analyzed for total acidity as H_2SO_4 by titration: Ref.: Reagent Chemicals, ACS Specifications, 1955.

The samples taken from the pouches shall be analyzed by the same electrolytic method for copper only, and shall show a minimum copper content of 8.0%.

APPENDIX III

I

Chemical Agent Specification Criteria

Water insoluble matter shall be determined by dissolving 50 g. of the copper sulfate in 300 ml. distilled water, adding 2 drops H_2SO_4, heating on a steam plate, and filtering through a tared platinum Gooch crucible. Wash thoroughly with hot distilled water, dry at 110°C., cool and weigh.

4.4 Sizing Tests.

Tests of the chemical raw materials for conformance to size specifications shall be run with standard sieves in a dry atmosphere. A sample of 200 g. shall be used for the test. The material shall be put through one sieve at a time. Standard sieve testing methods shall be used.

APPENDIX III

II

EXHIBIT A

COMPOSITION AND FORM. The sanitizing and odor control agent, TYPE II, may be any chemical or combination of chemicals which meet all the following requirements for a sanitary and odor control agent to be used in sanitary commodes.

REQUIREMENTS.

For acceptable sanitary (bacteriological) and odor control, the following criteria must be met:

1. The commode contents must maintain a pH of less than 5.0 in order to prevent the escape of ammoniacal odors, unless such odors are effectively masked (as is the case, for example, with the use of saponified cresylic acid compositions) at higher pH. It is reported that ammonia is detectable by odor at concentrations in air of less than 5 ppm, and that 20 ppm is readily recognized. For this criterion, it is suggested that the ammonia concentration in the air in the commode enclosure not exceed 10 ppm.

Ref: Patty, Industrial Hygiene and Toxicology, Vol. 2, 2nd Ed.
Elkins, Chemistry of Industrial Toxicology.

2. Sulfur based odors, viz., hydrogen sulfide and/or mercaptans, shall be reduced to a level considered unobjectionable, as judged by subjective organoleptic evaluation. Both hydrogen sulfide and methyl mercaptan are reported to be detectable by odor in air at concentrations of 0.02 to 0.05 ppm. For this criterion, it is suggested that the concentrations of these gasses in the air in the commode enclosure not exceed 0.1 ppm.

(It may be observed that the detectable concentrations of ammonia, hydrogen sulfide and methyl mercaptan are only a small fraction of the maximum allowable concentrations specified from a toxicity standpoint. These are reported to be, for eight hours' exposure in a working atmosphere, respectively 50, 20 and 50 ppm.)

Ref: ibid.

APPENDIX III

II

EXHIBIT A

3. There must be zero or only trace (less than 0.5 cc) gas formation as determined on commode contents samples tested by the Smith Tube Test, as described in Appendix I.

4. There shall be no evidence of coliform organisms as determined by APHA Brilliant Green Bile Confirmatory Test after a maximum of four days' continuous use of the commode when sampled not less than four hours after defecation useage.

5. There shall be no evidence of coliform organisms as determined in (4) after fourteen days' storage of the closed (and sealed, in the case of the dual-purpose lined drums) containers at storage temperatures of between 60 and 100°F. (This criterion may be relaxed if other conditions are satisfactory.)

6. Aerobe and anaerobe plate counts, as made by Standard APHA Methods, should be reduced to less than 10^5, preferably 10^3, after 24 hours' incubation at 30°C of a typical commode contents sample, and should not increase above this level after eight days' incubation at the same temperature.

7. The sanitizing agent as furnished should have low human toxicity during handling by all methods of exposure, viz., contact, ingestion or inhalation (dust or vapors). While no numerical standard for this criterion can be set at this time, generally the toxicity level should be 1 or less as rated on the scale used by N. Irving Sax in "Dangerous Properties of Industrial Materials, Second Edition."

8. If the sanitizing agent has an inherent odor of its own, such odor should be considered unobjectionable, under conditions of use, as judged by organoleptic evaluation.

9. The sanitizing agent should be amenable preferably to dry packaging, although liquids may be acceptable provided concentration is sufficiently high not to exceed same space and weight for equivalent dry chemical package.

APPENDIX III

II

EXHIBIT A

10. The material as furnished shall have a minimum shelf life of five (5) years without appreciable physical deterioration or loss of efficacy. No well defined accelerated test has been developed for the evaluation of this criterion, but reference can be made to the accelerated packaging test used in this project, i.e., storage in a controlled atmosphere cabinet at 70°C and 100% relative humidity for 135 hours.

11. As a general criterion, odor in the commode environment during continued use must be considered acceptable as judged by independent subjective organoleptic evaluation by a minimum of five (5) observers. This evaluation should be made at a time not less than five (5) minutes after use, in order to eliminate the effects of temporary odors generated during defecation.

SAMPLING AND TEST METHODS.

All the foregoing criteria have been predicated on evaluation of a proposed chemical agent under actual use conditions in a commode, either the dual-purpose 17.5 gallon lined drum or the sanitary vault. Experience under this project has shown that it is not possible as yet to show a satisfactory correlation between small scale laboratory tests and full scale use tests. The problem is aggravated by the time factor. Many agents show good performance during the first 24 to 48 hours of commode use, but lose their efficacy during continued use for periods of up to five days' duration. By the same token, standard use-dilution tests commonly employed for the evaluation of bactericides have been found of essentially no value in determining efficacy for this application. Only after further development of laboratory test procedures may it be possible to generate a means of evaluating proposed new agents without going to full scale testing.

APPENDIX III

II

EXHIBIT A

ADDENDA.

After completion of further work in this sanitation area, as described in Recommendations for Future Work, these criteria should be expanded to contain such items as:

Composition and volume of off-gasses under actual or simulated use conditions. Further research may be able to specify criteria in this area.

The necessity or requirement for the use of a vapor barrier.

The requirement for the addition of a wetting or penetrating agent to enhance the efficacy of the chemicals.

Specific enumeration of the more important or commonly expected pathogens which shall be destroyed.

Some specification on the possible transmittal of viruses.

APPENDIX IV

Chemical Agent Cost Data

Bulk Chemicals.

Copper Sulfate Pentahydrate

20 ton c. l., 100 lb. bags, f.o.b. El Paso	\$ 15.72/clb.
40 ton c. l., 100 lb. bags, f.o.b. El Paso	15.51/clb.

Sodium Bisulfate

40 ton c. l. min., bulk, f.o.b. Newark, California or Cleveland, Ohio	\$ 45.00/ton.
20 ton c. l., 400 lb. drums, f.o.b. "	48.66/ton.

Oleic Acid (Red Oil)

10 ton c. l., 400 lb. drums, f.o.b. Newark, N.J.	\$ 0.225/lb.
15 ton c. l., tanks, f.o.b. Newark, N.J.	0.200/lb.

Note: Oleic Acid is sold on the commodity market, and price varies considerably.

Estimated Total Package Costs.

Sanitizing Chemicals	0.5 lb. pouch	1.0 lb. pouch
Chemicals	\$ 0.05	\$ 0.10
Packaging stock(laminate)	0.012	0.017
Packaging stock(cartons) (est.)	0.002	0.002
Processing (including packing)	0.01	0.015-0.020
TOTAL	\$ 0.074	\$ 0.134-0.139

APPENDIX IV
Chemical Agent Cost Data

Oleic Acid	One Gallon
Chemical	$ 1.43
Can: "F" Style, rectangular, f.o.b. Chicago or Los Angeles, 1,000 units	0.240, 0.50 tinplate 0.250, 1.25 tinplate
Polyethylene Bottles, f.o.b. Los Angeles, 12,000 units	0.146
Packing stock (cartons)	0.03 for cans 0.04 for bottles
Filling (including packing)	0.055
TOTAL Maximum, for cans	$ 1.86
Minimum, for bottles	1.67

Unit Costs

Based on the foregoing estimated costs, and using the rate of one lb. of sanitizing chemical per 10 gallons of wastes, the unit costs become, for the sanitizing chemical:

per 17.5 gallon dual-purpose drum, (15 gallon useable volume)	$ 0.222
per vault commode, (70 gallon useable volume)	$ 0.938 - $ 0.973

For the oleic acid, at the rate of one pint per dual-purpose drum, and one gallon per vault commode, the unit cost becomes:

per 17.5 gallon dual-purpose drum	$ 0.209 - $ 0.233
per vault commode	$ 1.67 - $ 1.86

This relatively high cost for the oleic acid vapor barrier emphasizes the need for further evaluation of its contribution to total performance of the system. Even return to the earlier concept of using mineral oil, with its poorer filming qualities, would only reduce the cost to about $1.20 per gallon, which is still quite high relative to the sanitizing chemical cost.

APPENDIX V

Sanitary Vault Design and Cost Data

Design.

Overall design and assembly are shown in attached Dwg. No. 2760. Detailed design and fabrication Dwgs. Nos. 2761 to 2774 have been furnished separately, not a part of this report, and are on file for reference.

Materials.

Tank body material is 0.060 thick Type 1020 carbon steel.
Tank top is 5/8-inch Marine plywood.
Inside and outside of tank and top are finished with two coats of double base epoxy paint.
Special materials for accessories are shown on the reference Dwgs.

Weights.

Net weight of assembled tank and attached accessories, approx.	175 lbs.
Shipping weight	230 lbs.
Shipping weight, cast iron pump and base	28 lbs.
Shipping weight, pump accessories (hoses, etc.)	15 lbs.

Shipping cube dimensions, assembled tank less pump: 56.5x35.75x29.0 in.

Costs.

Time did not permit the development of a firm cost for large quantity production runs of the tank and accessories as designed, but it is estimated that maximum cost would be $ 300.00, and cost might be as low as $ 150.00 under the right circumstances, viz., a very large quantity and a fabricator set up and skilled in this type of work.

APPENDIX V

Sanitary Vault Design and Cost Data

Costs (cont'd).

The aluminum pump price is	$ 49.50
The coated aluminum pump price is	64.80
The cast iron pump price is	51.30

Additional design and material studies, as discussed in the body of the report, may lead to substantial reduction in these costs.